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ICE -OCEAN FOUR DIMENSIONAL STRUCTURE AND DYNAMICS

Annual Technical Report for The Period
31 March 1993 to 31 March 1994

Project Title: Ice-Ocean Four Dimensional Structure and Dynamics
Principal Investigator: F. Y. Sorrell
Institution: N.C. State University
Address: Box 7910, Raleigh, NC, 27695-7910
Telephone:919-515-5231; FAX:919-515-7968
E-mail:fys@chaos.cc.ncsu.edu
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OBJECTIVES

To understand the relationship among underice morphology, ice thickness and the structure of the oceanic boundary layer, an Autonomous Oceanographic Sampling Network is being developed. Each network consists of a base buoy and a number of Autonomous Oceanographic Vehicles (AOVs) at fixed levels. The base buoy serves as a navigation beacon, energy source, telemetry link and surface sensor platform. Each AOV functions as a subsurface sensor platform, short term data logger and programmable, navigable vessel. Development of system components capitalizes on advanced microprocessors, navigation and communication systems developed by DOD and industry for buoy and vessel technology. The first step will be to produce an AOV that has acceptable performance as a subsurface platform and which can dock with the base buoy and conduct data exchange.

APPROACH

The most immediate task has been to develop a vehicle that can serve as the AOV. Therefore, this phase of the work has been to develop a platform that meet all of the desired AOV functions. This consists of design, construction and testing of a prototype AOV. These tests include vehicle response to control system inputs and evaluation of control system and vehicle dynamics to provide suitable docking capability. It also includes development of appropriate sensor suits, data acquisition and storage systems, and integration of these ese systems into the vehicle payload. Finally, docking and interface connections to a suitable buoy system, consisting of data up-links and power transfer for recharging are to be developed and demonstrated.

TECHNICAL ACCOMPLISHMENTS

The major effort during this period has been final construction and testing of a suitable subsea platform to serve as the AOV. The present prototype is a 28 cm dia (10.75 inch) cylindrical shape with an overall length of 1.6 m (5.25 ft). The design of this vehicle has been completed , and a single prototype constructed during the prior reporting period. This prototype will take several different propulsion systems, to permit early evaluation of performance of the different propulsion systems. The design includes the initial control system, including control actuators and control surfaces.

Preliminary system payload requirements, consisting of an onboard computer, data acquisition and storage system, and sensor interface have been designed and constructed. The initial sensor payload has been primarily sensors to measure vehicle performance, and data acquisition has been focused on recording the output from these sensors. Therefore, the present system is used to measure and record overall vehicle performance during operation. The ability to record performance data during the AOV docking maneuver has also been implemented. The complete system has passed initial testing. Currently the performance of the AOV is under investigation and preliminary data has been obtained. Parameters sensed and recorded during performance evaluation are:

1. AOV magnetic heading and deviation from a desired heading.
2. Control system inputs to horizontal control system
3. Gyro stabilized rate of turn
4. Depth and rate of change in depth
5. Control system input to vertical control system
6. Thrustor power
7. Battery power consumption

In addition to AOV performance, testing has also been initiated a the magnetic homing and docking system. This system is required in order to have an integrated AOV and dock system. The magnetic homing system has been constructed and fully tested and debugged in land based trials. These trials employed a moving land vehicle for evaluation, and lead to some revisions in the prototype homing design. This revised design has been constructed and is incorporated into a preliminary underwater dock system. In addition design and construction of the on board sensing coils have been completed and these sensors have also been installed in the AOV. Parameters sensed and recorded during the docking tests are:

9. Range from the dock.
9. Direction from the dock
10. Vehicle angle to the dock.
11. Angle and rate of change of angle between the actual angle and that required for successful docking.

To date there have been two tests of the AOV operation in the docking mode. Software for data analysis has been written, and used to reduce preliminary performance data . In addition, a computer simulation of the AOV has been initiated. This simulation will be used to optimize the docking parameters to insure that docking can be accomplished under largest range of conditions. These data combined with the simulation should be useful to the overall program in AOV maneuvering and docking. This is because the data reduction and analysis methodology, as well as the sensors, can be easily moved to other undersea platforms.

PERSONNEL

The work as NCSU has been performed by the PI and one MS graduate student, James Jewell. It is anticipated that Mr. Jewell will compete the MS degree in June 94. Mr. John Ring, who started the MS degree in Mechanical and Aerospace Engineering in Spring 94 will take over after Mr. Jewell completes his degree. The electronic circuit design and much of the sensor interfacing have been done by Electronic Design Consultants, under a sub-contract from NCSU. The principal investigator for the sub-contract to Electronic Design Consultants is Dr. Michael D. Feezor. In addition, Electronic Design Consultants has also supported a field technician, Mr. Paul Blankenship, who has provided the lead in planning and carrying out the recent field experiments. Both have added a necessary and different perspective to the overall program. We continue to have a very good working relationship with Electronic Design Consultants, and plan on using them to provide a major part of the work in the future.

BUDGET & PROGRESS

The funding for the last two years has been at approximately one-half the level indicated in the original award. This funding has allowed what we believe to be reasonable progress, as indicated above. However, it has slowed progress on some items. This is particularly true in the field testing, which is one of the more expensive tasks. At this time we are planning to proceed with the original tasks, but at a slower rate than indicted in the original work plan.